

# Air Entraining and High-Range Water-Reducing Agent "KFLOW GT"\*

Eiji Sakou\*\* Motoyasu Yaji\*\*\* Sigeru Iijima\*\*\*\*

## 1 Introduction

Concrete with progressively higher quality and strength has been required as buildings have become more multi-storied. To meet this requirement, Kawasaki Steel produces several admixtures in the "KFLOW" series.

KFLOW series admixtures for high-quality and high-strength concrete are manufactured by K&D Fine Chemical Corporation, which is a joint venture between Kawasaki Steel and Dai-ichi Kogyo Seiyaku Co., Ltd. These admixtures are produced in a large-scale plant constructed in 1989 at Kawasaki Steel's Chiba Works.

"KFLOW GT" is a new addition to the series and shows a high water-reducing and good slump-retaining performance. This report presents the characteristics of this new product.

## 2 General Properties of KFLOW GT

Active ingredients: Salt of naphthalene sulfonic acid formalin condensate and special polymers

Appearance: Dark brown aqueous liquid

pH: 9-11

Specific gravity: 1.16-1.20

## 3 Characteristics of KFLOW GT

### (1) High Water-Reducing Capability

KFLOW GT shows a higher water-reducing performance than that of the usual air-entraining and water-reducing agents, the rate of water reduction from plain concrete reaching 18-25%. The comparative water-reducing performance of KFLOW GT is shown in **Table 1**.

By reducing the amount of mixing water, the strength of concrete can be increased. As long as the concrete is sufficiently workable to freely fill a molding box, the strength of hardened concrete depends upon the water/cement ratio, and not upon the amount of cement. It is well known that reducing the water/cement ratio increases the strength of concrete.

The building trend in recent years has been toward a greater number of storeys and concrete with progressively higher strength has been required. However, due to a shortage of good-quality sand, the workability of concrete has worsened so that the amount of mixing water has tended to be increased. Under these circumstances, admixtures with high water-reducing capability play an important role.

Table 1 Comparative water-reducing properties

Admixture	Quantity of water per unit volume concrete (kg/m <sup>3</sup> )	Water reducing ratio (%)
None <sup>a)</sup>	208	0
Air entraining agent	191	8
Air entraining water reducing agent	183	12
KFLOW GT <sup>b)</sup>	166	20

<sup>a)</sup> Plain concrete

<sup>b)</sup> High performance air entraining water reducing agent

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\*\* Director, General Manager, Technical Div., K&D Fine Chemical Corp.

\*\*\* Manager, Chemical Products Dept., Chemical Div.

\*\*\*\* Chief Chemist, Application Research Institute, Dai-ichi Kogyo Seiyaku Co., Ltd.

Reducing the amount of mixing water is also effective for improving watertightness by reducing bleeding, for reducing drying shrinkage, and for improving long-term durability. Economic advantages from a reduction in the specific cement content can also be expected.

(2) High Slump-Retaining Performance Permits Admixing at the Batching Plant

The special polymer used as one of the constituents of KFLOW GT makes the slump loss very low, so that admixing at the batching plant is possible in the same manner as with normal air-entraining and water-reducing agents.

Although admixtures with a rate of water reduction above 20% already exist, they do not provide enough slump retention. While they can be used for concrete products manufactured in a factory, they have to be added at the job site when being used with ready mixed concrete for building construction.

The high slump-retaining performance of KFLOW GT offers a significant advantage over other admixtures.

(3) KFLOW GT Is a Non-chloride Type of Admixture

4 Characteristics of the Fresh Concrete

The characteristics of fresh concrete containing KFLOW GT are shown below in comparison with those of common air-entraining and water-reducing agents.

Concrete mixture (60 l) were prepared in a laboratory mixer with the mix proportion shown in Table 2. For the slump-loss test, the prepared concrete mixes were allowed to stand and then remixed before testing. Plots of the slump and air content ratio versus time after starting the initial mixing are shown in Figs. 1 and 2, respectively. The degrees of slump loss and change in air content ratio of the mixes containing KFLOW GT are both superior to those of common air-entraining and water-reducing agents.

Plots of the bleeding ratio versus time are shown in Fig. 3, the mixture containing KFLOW GT indicating much lower bleeding than with the other air-entraining and water-reducing agents.

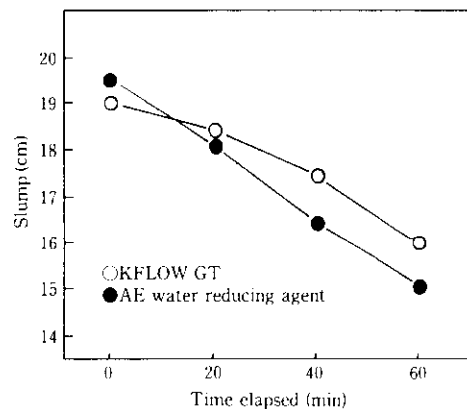


Fig. 1 Change in slump with time

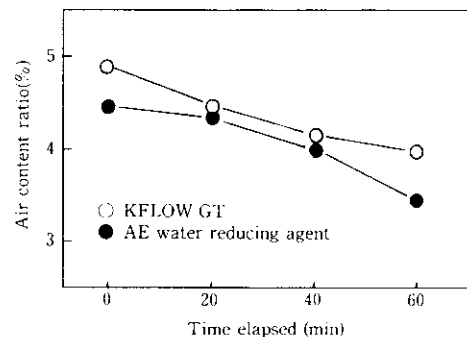


Fig. 2 Change in air content ratio with time

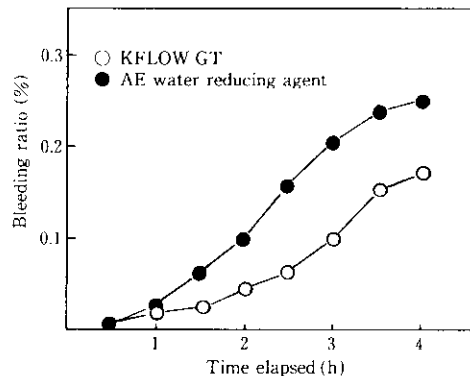


Fig. 3 Change in bleeding ratio with time

Table 2 Mix proportions of the concrete samples tested

Admixture	W/C (%)	S/a (%)	Quantity/unit volume of concrete (kg/m <sup>3</sup> )			
			W	C	S	G
AE water reducing agent (C×0.25%)	52	46	184	354	787	951
KFLOW GT (C×1.3%)	52	46	164	319	823	991

W: Water C: Cement S: Sand G: Gravel S/a: S/(S+G)

## 5 Characteristics of the Hardened Concrete

The compressive strength of the hardened concrete samples was measured by the method described in JIS A6204 "Chemical Admixtures for Concretes", and the obtained results are shown in **Table 3**. According to this standard, it is required that the ratio of the compressive strength of the admixed concrete to that of plain concrete must be over 115% after 3 days, and 110% after 7 days and 28 days. The data in Table 3 show that the strength ratio of the concrete containing KFLOW GT exceeds 150% after 3 days, and 120% after 7 and 28 days. These figures prove that KFLOW GT has outstanding characteristics for increasing the strength of concrete.

Table 3 Comparison of compressive strength between plain concrete and KFLOW GT mixed concrete

		(N/mm <sup>2</sup> )			
		Plain concrete		KFLOW GT	
Slump (cm)	Quantity of water <sup>a)</sup> (kg/m <sup>3</sup> )	8	18	8	18
		198	227	160	182
After 3 d		11.4	9.1	17.1	14.6
After 7 d		19.9	14.9	24.5	22.3
After 28 d		29.5	24.6	35.6	31.7

<sup>a)</sup> Quantity of water per unit volume of concrete

## 6 How to Use KFLOW GT

### 6.1 Standard Mixing Quantity

The standard mixing quantity of KFLOW GT is 1.3% by weight of cement. However, as the optimum mixture will be affected by the kind of materials, the type of mixer, temperature, etc., it is recommended that the optimum mixing ratio is determined by test mixing.

### 6.2 Method for Controlling the Air Content

To adjust the air content in the concrete, an air-entraining agent is required. Hitenol 330 F produced by Dai-ichi Kogyo Seiyaku Co. Ltd., is recommended for combining with KFLOW GT. A 2 ml addition of Hitenol 330 F diluted 100 times with water and added to 1 kg of cement increases the air content in the obtained concrete by 1%. Test mixing should be done to achieve the required air content.

## 7 Concluding Remarks

KFLOW GT is a high-performance agent for entraining air and reducing water in concrete. The product has a much higher water-reducing performance than conventional air-entraining and water-reducing agents, and it can also be used at the batching plant for ready-mixed concrete. This product has already earned a high reputation, and continuous efforts are being made to develop even better new products.

**For Further Information**, Please contact to:

Chemical Products Dept., Chemical Div.,  
Kawasaki Steel Corp.

Fax: 03 (3597) 4990 Phone: 03 (3597) 4981